STRENGTH IN NUMBERS THE REMARKABLE POTENTIAL OF (REALLY) SMALL COMBATANTS

Jimmy Drennan

You are a tactical commander tasked with a mission to seek out and destroy one of the enemy's premier capital ships in his home waters. You have two potential striking forces at your disposal: a world-class surface combatant of your own with a 99 percent probability of mission success ($P_s = 0.99$) or a squadron of eight independently operating, missile-carrying small combatants, each with a chance of successfully completing the mission no better than a coin flip ($P_s = 0.5$). Do you go with the almost sure thing and choose to send in your large combatant? As it turns out, the squadron of small combatants has an even higher overall P_s but let us now assume that you have advanced to operational commander. You might have more concerns than just overall P_s. What are the defensive and logistical requirements for each option? How much fleet investment are you risking with each option? What will it cost to replace the asset(s) if lost? What capability does the striking force have after successful enemy action (i.e., resilience)? An analysis of these factors, intentionally designed to disadvantage small combatants, is actually overwhelmingly in their favor. The results verify what naval strategists and tacticians have long known—that for certain offensive missions, an independently operating group of even marginally capable platforms can outperform a single large combatant at lower cost and less risk to the mission.

THE WAR-AT-SEA FLOTILLA: A TEST CASE

Retired U.S. Navy captains Jeff Kline and Wayne Hughes introduced "Between Peace and the Air-Sea Battle: A War at Sea Strategy," in which they describe a flotilla of small, missile-carrying surface combatants designed to challenge Chinese aggression in East Asian waters.[1] The flotilla ships would utilize largely independent tactics that relied little on networked command and control, to produce a powerful cumulative combat capability.

What would the flotilla look like? In rough terms, we envision individual small combatants of about six hundred tons carrying six or eight surface-to-surface missiles and depending on soft kill and point defense for survival, aided by offboard manned or unmanned aerial vehicles for surveillance and tactical scouting. To paint a picture of

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> possible structures, we contemplate as the smallest element a mutually supporting pair, a squadron to comprise eight vessels, and the entire force to be eight squadrons, of which half would be in East Asian waters. The units costing less than $100 million each, the entire force would require a very small part of the shipbuilding budget.[2]

This flotilla concept provides an ideal test case to compare against a world-class surface combatant, but first we must establish a few key assumptions on which this analysis is based.

Statistical Independence. The math behind this analysis hinges on the idea that the outcome of one small combatant's engagement has no effect on the others in the squadron. While true statistical independence is nearly impossible to achieve in real-world naval operations, the "war-at-sea flotilla" concept is modeled closely with independently operating units, the potential for various ship classes, and the inclusion of allied navies, which may use different tactics, techniques, and procedures (TTPs). This concept of operations is a major departure from today's heavily networked forces that generate combat power through the integrated actions of several units. In those forces, the actions of one unit can have profound impact on the effectiveness of another.

Defensive and Logistical Requirements. For the purposes of this analysis, we will assume that the defensive and logistical requirements are roughly equivalent for both the small combatant squadron and the large combatant. Both would require defensive support in warfare areas not directly related to the current mission. Even a multimission, blue-water combatant would employ nonorganic support, such as maritime patrol aircraft or early-warning assets, to watch its back while conducting a focused offensive mission. As for logistics, any surface asset would need an oiler nearby to conduct sustained operations in enemy waters. A nuclear-powered aircraft carrier would still require periodic support to replenish its stores of jet fuel. The logistics tail would be shorter for a large combatant than for a flotilla, since it carries much of its own maintenance and supply support, but that can be a detriment in a mission involving an exchange of missile salvos. While the structure of defensive and logistical support may differ greatly between the flotilla and the large combatant, one can assume the drain on resources would be about the same for both options.

Unit Cost. Hughes and Kline estimate the unit cost of the flotilla small combatants to be at eighty million dollars. Therefore, a squadron of eight combatants would cost $640 million. The unit cost of the large combatant is assumed to be a billion dollars, which is an underestimate for relevant U.S. Navy platforms. The cost estimates in this analysis are intentionally set up to work against the flotilla concept in order to emphasize its potential for savings.

Enemy Capabilities. To disadvantage further the flotilla concept, let us assume the small combatants are significantly overmatched by the enemy combatant. In a first strike, the enemy combatant is capable of simultaneously targeting six of the eight squadron combatants. Against the large combatant, it is capable of conducting a devastating mission kill in which the ship may not be sunk but the cost of repairing it to full mission capability would be comparable to the unit cost. As a starting argument, we will presume in either case the enemy can achieve a mission kill with 10 percent probability ($P_{mk} = 0.10$), since both striking forces have similar levels of defensive support. One might argue that P_{mk} should be lower for the large combatant, because it possesses superior self-defense capabilities; however, it could also be argued that the mobile, distributed nature of the small-combatant squadron compensates for each ship's lack of self-defense by complicating the enemy's targeting process. It may be relatively easy for the enemy to target one or two of the small combatants, but it remains a challenge to eliminate at one stroke the entire squadron.

SELECTING THE RIGHT STRIKING FORCE: ANALYSIS RESULTS

Using the generic introductory scenario, we can compare the small combatant squadron with the large combatant in terms of performance, cost, and risk.

Overall Effectiveness. We are given the overall effectiveness of the large combatant as $P_s = 0.99$ and the individual effectiveness of the small combatants as $P_{s,ship} = 0.5$. To determine the overall effectiveness of the squadron, it is easiest to first estimate the probability that none of the small combatants successfully accomplish their mission. The probability that any one small combatant will not accomplish the mission is

$$1 - P_{s,ship} = 0.5.$$

Since the outcome of each engagement is estimated as independent of one another, the probability that none of the eight small combatants accomplish the mission is

$$(1 - P_{s,ship})8 = 0.004.$$

The probability that at least one of the small combatants accomplishes the mission is the converse of the previous result, or

$$1 - (1 - P_{s,ship})8 = 0.996.$$

In other words, the squadron has a 99.6 percent probability of success vice 99 percent for the large combatant. This may not seem like much of an improvement, but it is more remarkable when considering the unit cost of each option.

Cost-Effectiveness. The unit costs are given as one billion dollars for the large combatant and eighty million for the small combatant, so the squadron of eight small combatants is the more affordable option, at $640 million. In addition, it has been established that the squadron can outperform the large combatant for this particular offensive mission, in which the individual squadron ships are actually overmatched by the enemy. The squadron not only is more cost-effective than the large combatant but actually delivers better performance at lower cost. As a commander, would you rather invest a billion dollars in a striking force that fails ten times in a thousand attempts or save $360 million with a striking force that fails only four times in a thousand attempts? To put it another way, if you were to invest the same billion dollars in twelve small combatants, you could deliver a striking force that failed only two times in ten thousand attempts ($P_s = 0.9998$).

Resilience after Enemy Action. One way to consider risk is to look at the impact to the mission if the enemy is able to consummate successfully a first attack. We have assumed the enemy is equally capable of attacking the large combatant and the squadron of small combatants. If the enemy combatant achieves a simultaneous mission kill against six of the small combatants, only two will remain to continue the mission. These two small combatants have a combined 75 percent probability of successfully completing the mission. On the other hand, if the enemy successfully conducts a mission kill against the large combatant, the probability of successfully completing the mission is 0 percent, and you lose the other warfare-area capabilities that the large combatant could bring to bear in other missions. The additional investment required to provide onboard logistics support is also lost.

Another way to look at this risk is to calculate the expected damage cost of each option in the long run. Assuming the enemy is able to conduct devastating mission kills (in which the repair costs are comparable to the unit cost) a conservative 10 percent of the time ($P_{mk} = 0.1$) for both the large and small combatants, then the expected damage cost for the large combatant is

$$E(\text{cost})_{\text{large}} = (0.1)(\$1\text{B}) = \$100 \text{ million}.$$

Likewise, the expected damage cost for the squadron of small combatants is

$$E(\text{cost})_{\text{squadron}} = (0.1)(\$80\text{M} \cdot 6) = \$48 \text{ million}.$$

In the long run, the enemy is expected to cause fifty-two million dollars less damage per mission in the case of the small combatants. Even if the enemy were more likely to succeed in targeting six small combatants simultaneously, how much would you as a commander be willing to pay for 75 percent follow-on capability vice 0 percent?

LESS COMMUNICATIONS, LESS COST, MORE COMBAT POWER: ANALYSIS INSIGHTS

The results of this analysis seem to indicate that the squadron of small combatants is an obvious choice for naval missions involving direct action against the enemy fleet. Yet the scenario described is quite generic and says nothing about the actual TTPs and systems the squadron will utilize in prosecuting the enemy. How can such a generic scenario really prove anything about the effectiveness of small combatants? The key is that two fundamental principles underlie this analysis and can be applied in much broader terms.

First, independently operating, redundant, and at least marginally capable units will greatly increase any system's overall effectiveness, primarily because unit faults and errors are not permitted to propagate through the system as they would in net-centric warfare (e.g., flawed group tactics or a false link track). For surface combatants, an individual effectiveness of 50 percent is sufficient to produce affordably a formidable striking force. For less expensive systems, that number may be even less. Ultimately, this kind of system is so effective because it is highly unlikely that none of the individual units will successfully complete the mission.

The second principle that contributes to the appeal of the small combatant squadron is that the price of military systems increases exponentially as you attempt to improve individual unit performance closer and closer to perfection. Most of our warships today are designed well past the "knee" in the cost curve. Small combatants can be built with marginal capability at (relatively) low cost. One new concept illustrates how less-capable ships can affordably produce equivalent performance to that of more capable ones in certain situations. In his essay "Buy Fords, Not Ferraris," Captain Henry Hendrix, USN, proposes "influence squadrons," composed of light amphibious ships, large combatants, littoral combat ships (LCSs), and small combatants, to alleviate the need for some carrier strike groups, with a smaller price tag.[3] The purpose of the war-at-sea flotilla, however, is not to replace current fleet assets but to fill a vital niche not now covered to fight a war at sea in littoral waters. Therefore, the cost must be small. Hughes and Kline suggest the cost of maintaining a fleet of sixty-four flotilla ships, steady state, should be less than 3 or 4 percent of the shipbuilding budget.[4]

THINK SMALL: ANALYSIS CONCLUSION AND RECOMMENDATIONS

One look at the writings of Sir Julian Corbett or Captain Hughes's *Fleet Tactics and Coastal Combat* will show the reader that the benefit of small combatants in certain aspects of naval warfare is not a new discovery.[5] In fact, this analysis may seem like the kind of thinking that led to the development of the LCS, which was, after all, war gaming and analysis that advocated small combatants.[6] The LCS

program is not, however, a realization of the principles discussed in this analysis. Both *Freedom*- and *Independence*-class LCSs are large, multimission warships (albeit one mission at a time) in which mission packages cost a premium to achieve high probabilities of success. The war-at-sea flotilla, if constructed as Hughes and Kline recommend, would exemplify the advantages of independently operating small combatants.

None of this is meant to condemn the LCS or any other ship class. Every ship in the U.S. fleet, along with the distributed networks that multiply its combat power, has an important role in the mission of winning the nation's wars, deterring aggression, and maintaining freedom of the seas. The purpose here is to provide an analytical basis for including independently operating squadrons of small combatants in the discussion for future force structure. For targeted offensive missions at sea, concepts such as the war-at-sea flotilla can provide higher performance than large combatants at lower cost and with greater resilience with respect to enemy action. In today's fiscal reality and tomorrow's projected operational environment, that is a combination Navy leaders should not ignore.

DEBATING THE WAR-AT-SEA FLOTILLA: ANALYSIS CRITICISM AND RESPONSE

When this article originally appeared on the blog *Information Dissemination* in April 2013, it generated intense debate on various discussion boards. The following is a representative sample of the most common composite criticisms of the war-at-sea-flotilla concept and associated analysis. Not included here are the comments that focused on the merits of the war-at-sea strategy itself. Although this analysis is intended to support the war-at-sea strategy, it is not meant to be its defense. Other, more effective strategic options may certainly exist. The merits of Hughes and Kline's work are taken at face value for the purposes of this analysis. This article analyzes the tactical implications in a very focused and basic scenario to show that a squadron of small combatants, which do not exist in today's fleet inventory, could be more effective than a large combatant in certain offensive missions against an enemy fleet.

The analysis is fine as far as it goes; however, like Hughes's work, it considers the engagement in isolation. Today's militaries, including the obvious target of China, fight in a combined-arms environment. For instance, the impact of airpower is ignored. Small combatants are extremely vulnerable to aircraft and would be susceptible to defeat in detail long before reaching engagement range.

The impacts of combined arms and supporting assets, from both the enemy and friendly perspectives, are actually embedded in this analysis. On the

offensive side, the type of attack need not be specified. Although antiship cruise missiles are the obvious choice, deception tactics used to get close to the enemy combined with a single torpedo may also be very effective. On the defensive side, both the large and small combatants would require area-defense support (in all warfare areas). Certainly the large combatant would be more capable of self-defense but, in the case of an Aegis-equipped destroyer/cruiser, it is exactly this added defensive capability (in addition to other warfare capabilities, such as ballistic-missile defense and antisubmarine warfare) that requires area-defense support. As a commander, would you risk losing an Aegis combatant by sending it on an offensive mission in hostile territory alone and unafraid? As for the enemy, any supporting capabilities that can be brought to bear on the striking force are accounted for in the intentionally generalized probability of mission success (P_s). The individual small combatant only succeeds half the time ($P_s = 0.5$), not just because of its own limitations, but also because of the enemy's capabilities.

A larger combatant, such as an Arleigh Burke*–class guided-missile destroyer, would have a better chance of survival to engagement.*

Granted, the large combatant may be more capable of preventing missile impact (although small combatants have an inherent stealth advantage and soft-kill techniques continue to level the playing field), but even if the small combatants were much more likely to take missile hits, the resilient capability of the overall squadron may very well be worth the premium paid in damage costs.

How do you convince the American public that people who join the Navy are to serve on ships that we know will die fast in a war? Do you tell them that it is cost-effective to lose six of eight ships, as long as they kill one of the enemy's?

Consider which is worse: a large combatant goes toe to toe with an enemy combatant, takes a devastating missile salvo that kills a significant portion of its crew, and gets put out of the fight for months with extreme damage repairs while the enemy continues on its way; or a squadron of eight small combatants loses six ships but manages to accomplish the mission with the remaining two by destroying the enemy combatant. These are not "ships designed to lose"; this is a squadron, and therefore a Navy, designed to win.

These small ships must rely on networks to be effective. What happens when the Chinese jam/spoof U.S. networks on the opening day of conflict?

It is precisely the opposite that makes the war-at-sea flotilla so effective. Since the flotilla ships are not connected in a network, their operations can be considered independent, which leads to the high overall P_s described in this analysis.

It is the independent nature of the small combatants from which the squadron derives its power. In fact, the lack of an elaborate network reduces the flotilla's electromagnetic signature, further increasing its combat effectiveness by making it harder to detect.

I just don't see eighty million dollars being the price per unit at the end of the day.

A common criticism was that eighty million dollars is a gross underestimate for a small combatant. Even if the estimate were off by 100 percent and the actual unit cost were $160 million, the entire squadron of eight ships would cost $1.28 billion—still less than an *Arleigh Burke* guided-missile destroyer. For argument's sake, assume the costs were equal. At that point, the squadron would yield higher effectiveness and more resilience for the same price (for the particular mission in question).

Surface combatants serve as a mobile base for maritime helicopters and increasingly capable vertical-takeoff unmanned aerial vehicles. A large helicopter deck and hangar are arguably the primary strengths of a modern surface combatant. Yet nowhere does one see that the author's proposed "eighty-million-dollar small combatant" would be capable of supporting a "helo" or even a Fire Scout.

While this is certainly a narrow view of surface warfare, it is often valid in today's operations. The war-at-sea flotilla, however, is predicated on the notion that at some point in the future the U.S. Navy will be called on to conduct offensive operations against modern enemy combatants at sea. The primary strength of the small combatants described here would be their ability to launch a devastating salvo of next-generation cruise missiles. If an organic air asset were deemed to be absolutely mission critical, unit cost would certainly increase, but it would not invalidate the concept (refer to the unit-cost criticism above).

If we are focused on launching cruise missiles better, we can do it better and cheaper from a dedicated Navy ship. Drones can provide comparable endurance, less cost and risk, and larger launch envelopes. An International Organization for Standardization–sized container of cruise missiles could be put on any allied ship with a Navy team and become another launch node. Letters of marque could be issued, and this same modular payload could be operated by Navy technicians on eager Philippine and Vietnamese ships. If we take the Chief of Naval Operations' direction to heart—payloads over platforms—we really just need a box of missiles and need to focus on the P_{mk} *of the missile.*

Drones and converted containerships are both intriguing ideas for potential launch platforms, although each has its drawbacks. Achieving persistent presence

with land-based drones comparable to that provided by a flotilla may be a challenge, whereas naval drones are simply extensions of ships, which brings the discussion back to large versus small combatants. Containerships could certainly be inexpensive alternatives to purpose-built combatants, but the rules of engagement and political challenges to the use of neutral shipping as a cover to engage the enemy may be too great to overcome. Nevertheless, both ideas speak to the heart of this analysis: it is not really about small ships but about redundant systems of inexpensive nodes operating independently to produce impressive combat effectiveness.

Smaller ships need a logistics force to support their operations or an advanced base from which to operate close to the Chinese coast.

All ships need logistics forces to support their operations. The logistical requirements of a flotilla of small ships are only more pronounced, because the ships carry fewer organic logistical capabilities on board than do large combatants. However, the added logistical capabilities of large combatants can be a liability in open hostilities, because more personnel and resources in the overall supply chain are lost when the ship takes damage. When a small combatant is hit by the enemy, the overall supply chain is barely affected.

Doesn't the U.S. Navy already have a small, eighty-million-dollar antiship platform in the guise of the F/A-18E/F Super Hornet?

The comparison to naval aviation might be compelling, except that a naval tactical aircraft has to launch from an aircraft carrier, which would be the relevant unit to compare against the squadron of small combatants. The tactical range of the F-18 does not allow for the argument that the carrier itself would not be involved in the engagement. Even if the carrier's probability of success were 99.999 percent, the expected damage cost in the long term (in both financial and strategic terms) would be prohibitive.

This type of analysis, essentially identical to Hughes's approach, is extremely simplistic, so much so that meaningful conclusions cannot be drawn. In fact, the results can be misleading if the limitations are not clearly recognized.

Simple analyses can produce valuable insights that can be developed into integrated courses of action. Of course, strategy is not the summation of tactics, but it is important to start simple, or else one is left with a Navy that goes nowhere—or worse, a Navy that does not understand where it is going.

NOTES

The essay on which the present essay is based was originally posted on the website *Information Dissemination,* at www.informationdissemination.net/2013/04/strength-in-numbers-remarkable.html.

1. Jeffrey E. Kline and Wayne P. Hughes, Jr., "Between Peace and the Air-Sea Battle: A War at Sea Strategy," *Naval War College Review* 65, no. 4 (Autumn 2012), pp. 35–40.
2. Ibid., p. 38.
3. Henry Hendrix, "Buy Fords, Not Ferraris," U.S. Naval Institute *Proceedings* 135/4/1,274 (April 2009).
4. Kline and Hughes, "Between Peace and the Air-Sea Battle."
5. Wayne P. Hughes, Jr., *Fleet Tactics and Coastal Combat* (Annapolis, Md.: Naval Institute Press, 2010), p. 378.
6. Duncan Long and Stuart Johnson, *The Littoral Combat Ship: From Concept to Program* (Washington, D.C.: National Defense Univ., 2007), pp. 5–9.